Terrestrial Balloon 10-Mbps to 1-Gbps Communications using Commercial Satellites and NASA TDRSS, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

A Ka-band satellite communications flight terminal will be designed for use by NASA Terrestrial Balloons to provide 10-Mbps to 1-Gbps satellite communications transmit links and low data rate command receive links using either commercial Ka-band satellites or NASA TDRSS satellites. The transmit Ka-band frequencies of NASA TDRSS satellites go up to 27.5-Ghz and are adjacent to the commercial Ka-band satellite frequencies starting at 27.5-Ghz, so this single Ka-band flight terminal will be able to tune to both the NASA TDRSS and commercial Ka-band satellite frequencies. This Ka-band flight terminal will be shown to have a lower size, weight, and power (SWaP) to the existing NASA Balloon satcom terminals.

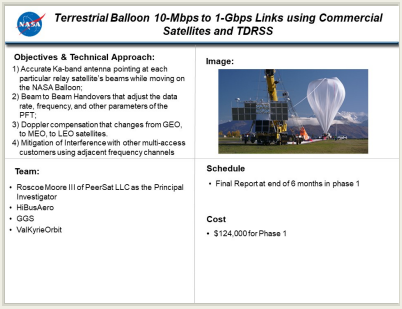
A relatively low-cost 2-dimensional electronic beamforming antenna will be tested for its capability to point a high-gain antenna beam at the existing commercial or TDRSS Ka-band satellites in geostationary orbit (GEO) as the terrestrial balloon is moving slowly in relation to those GEO satellites. Testing will also be performed on the ability of this same beamforming antenna to point at and track existing O3b middle Earth orbit (MEO) and TeleSat and SpaceX low Earth orbit (LEO) Ka-band satellites that will be moving much faster relative to the balloon.

The performance of this Ka-band flight terminal will change dramatically from 10-Mbps to 1-Gbps depending on which Ka-band satellite and which satellite beam in which GEO, MEO, or LEO orbit the balloon's terminal decides to access. Software defined radio (SDR) waveform firmware and flight radio hardware will be tested through a channel simulator that uses software to simulate a moving NASA Balloon successfully closing satcom links through satellites with different link characteristics. Beam to beam handovers, frequency channel interference mitigation, and the different Doppler shift compensation needed for the different GEO, MEO, and LEO orbits will be tested in these simulations of the SDR firmware and hardware.

Anticipated Benefits

NASA Terrestrial Balloons currently use a TDRSS satellite communications terminal and an Iridium satellite communications terminal for balloon communications.At present, NASA is limited to data rates of 150-Kbps using the TDRSS S-band communications service.

The 10-Mbps to 1-Gbps data rate of the proposed Ka-band terminal would be a 100 to 10,000 times improvement. The proposed Ka-band terminal at under 10-kg could probably be added to these balloons without replacing the other



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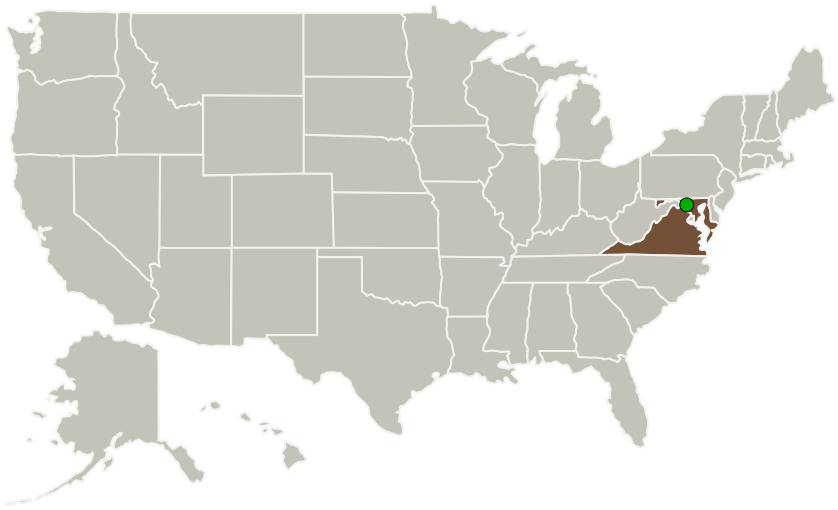
terminals.

The low size, weight, and power (SWaP) of the proposed Ka-band terminal at under 10-kg should make it attractive to the market for over 100,000 commercial (not consumer) unmanned aerial vehicles (UAVs) sold each year that would like high data rate satellite communications of payload data when these UAV aircraft are out of range of their ground stations. With different software defined radio (SDR) firmware, much of this same Ka-band terminal hardware could be used in the automobile market.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
PeerSat, LLC	Lead Organization	Industry	Arlington, Virginia
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
Maryland	Virginia

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

PeerSat, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

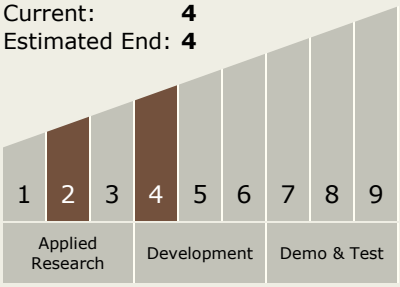
Carlos Torrez

Principal Investigator:

Roscoe Moore

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



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Project Transitions

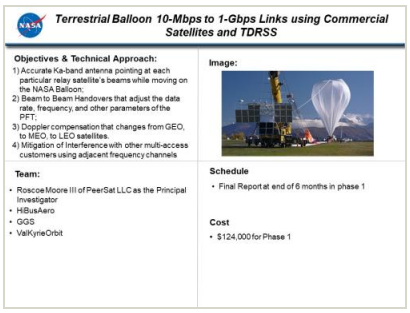
July 2018: Project Start

February 2019: Closed out

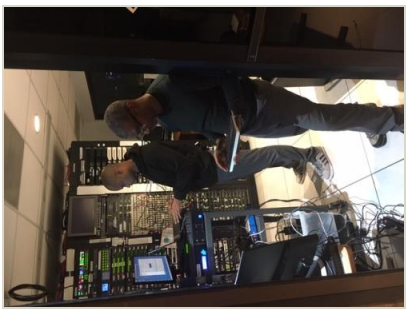
Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/138534)*

Images



Briefing Chart Image
Terrestrial Balloon 10-Mbps to 1-Gbps Communications using Commercial Satellites and NASA TDRSS, Phase I *(https://techport.nasa.gov/image/128056)*



Final Summary Chart Image
Terrestrial Balloon 10-Mbps to 1-Gbps Communications using Commercial Satellites and NASA TDRSS, Phase I *(https://techport.nasa.gov/image/128494)*

Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.1 Optical Communications
    - TX05.1.6 Optimetrics

Target Destination

Earth